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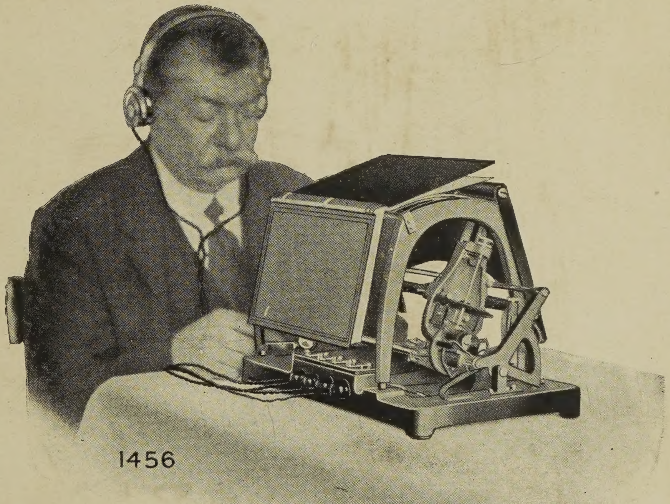
BARR AND STROUD, LIMITED.

THE OPTOPHONE.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BARR AND STROUD, LTD., GLASGOW, SCOTLAND.
LONDON OFFICE: 15 Victoria Street, Westminster, S.W. I.

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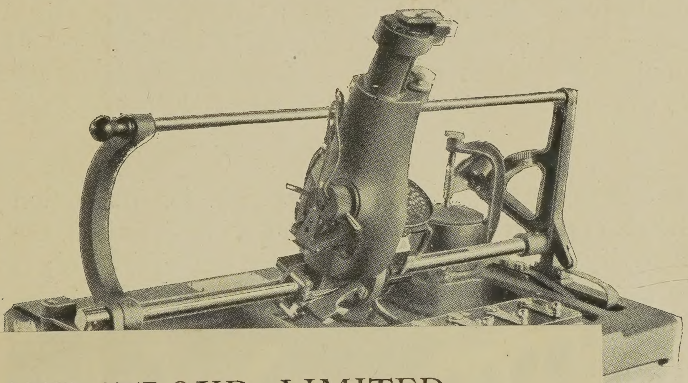

BARR AND STROUD, LIMITED.
CAXTON STREET, ANNIESLAND, GLASGOW.

The Optophone may be seen at the above address, or at the Firm's London Office,

15 Victoria Street, Westminster.
(*Telephone No.* Victoria 7397.)

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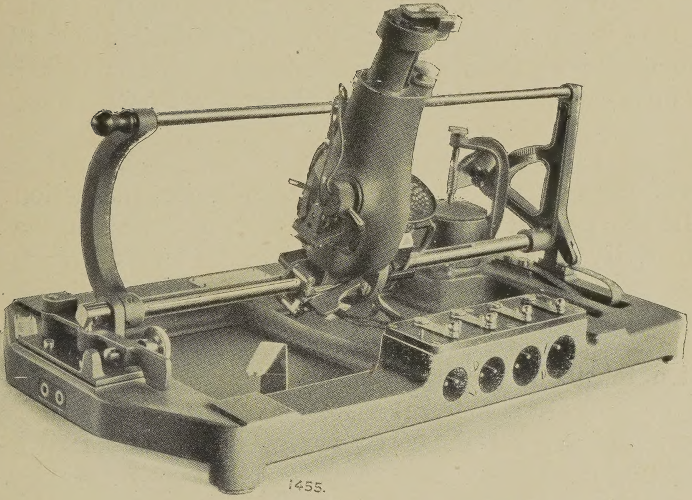

Fig. 1. The Optophone, with Book Rest removed.

The Optophone, the invention of Dr. E. E. Fournier d'Albe of London, has been modified and developed by Messrs. Barr and Stroud, Limited, of Glasgow. Its purpose is to enable the blind to read ordinary printed matter—such as books or newspapers. This is accomplished by producing in a telephone receiver series of musical notes forming tunes or musical motifs, representing the various letters as these are passed over by the instrument in traversing a line of printing.

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Braille and the Moon, adapted to be read by the sense of touch. These methods are subject to considerable disadvantages, such as the necessity for having specially printed, expensive and bulky books and the consequent limited amount of literature available, and the difficulty of acquiring the necessary sensitiveness of touch, especially by adult blind persons.

These disadvantages are overcome by the Optophone. It renders all ordinary printed works, including type-written matter, available to the blind. It depends not upon the sense of touch but upon hearing, which is usually quite sufficiently sensitive with the majority of blind persons, and reasonable facility in reading by its use can be attained after comparatively few lessons.

Selenium. The instrument depends for its action upon a remarkable property of the chemical element Selenium, the electrical conductivity of which in one of its physical forms (grey crystalline) varies greatly in accordance with the amount of light to which it is exposed.

If a telephone receiver (essentially an instrument sensitive to changes in electrical currents) is connected in series with an electric battery and a porcelain tablet having on its surface two separate conducting lines of graphite connected together or bridged over by light-sensitive selenium, a current will pass through the telephone, and the current will vary as the lighting of the tablet is varied. The prepared tablet is called a "selenium bridge." When flashes of light are thrown on to the selenium bridge at a rate of 256 per second, the current will rise and fall at that rate and the telephone will sing out the note C (middle C of the piano). If the pulsations of the light are at half that frequency, that is, 128 per second, the telephone will sing out C an octave lower, and with 512 pulsations per second, the C one octave higher and so on. The telephone can therefore be made to sing any tune by the proper succession of sets of pulsations of light applied to the selenium bridge.

In the Optophone a selenium bridge is exposed to successions of sets of light pulsations, which vary according to the forms of letters as these are passed over in traversing a line of printed type, each letter being indicated in the telephone by a characteristic motif comprising successions of single notes and chords. Printed letters are thus translated by the Optophone into a sound alphabet, which can be readily learned.

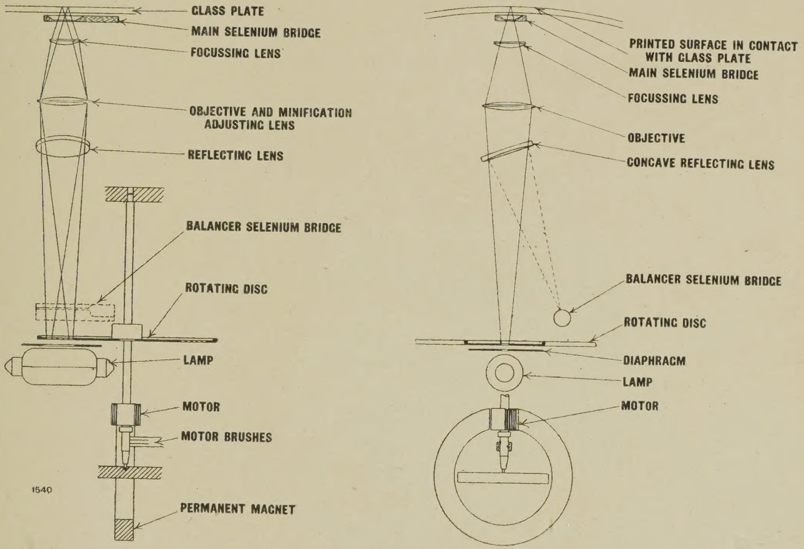

Fig. 2.

Fig. 3.

Diagrammatic Arrangement of Optophone.

Arrangement. The arrangement of the Optophone is illustrated diagrammatically in Figs. 2 and 3. The printed page to be read is placed face downwards on a glass plate supported on a suitable stand. Beneath the plate is a tablet of porcelain pierced with an aperture to permit the passage of light upwards and so through the glass on to the paper. The upper surface of the tablet—around the aperture—is prepared as a sensitive selenium bridge and connected up to a battery and a telephone. The selenium bridge receives only light reflected from the page. The light used is obtained from a small straight filament electric lamp placed beneath a rotating disc perforated with small holes arranged in five concentric circles near its edge. This disc is illustrated in

Fig. 4. For the sake of clearness and simplicity in the diagrammatic arrangement, Figs. 2 and 3, the lamp is shown immediately below the rotating disc. In the instruments now being made the lamp is so arranged, in conjunction with a reflecting prism and cylindrical lenses, that an image of the filament is produced in the plane of the disc, radially across the circles of holes.

The disc is kept in rapid rotation by means of a tiny magneto-electric motor driven by current from small secondary cells. Above the disc there is an optical system which throws on to the paper an image of the lamp filament as it would be seen through the perforations in the disc. By this means the light that falls on the printed matter forms five bright spots in line, forming what is called the "scala." Each spot is pulsating at a rate corresponding to the number of holes in the circle of perforations to which it belongs multiplied by the number of revolutions per second of the disc. There are 18 holes in the innermost circle, 24, 27, 30 and 36 in the other circles respectively, and if the disc makes 21⅓ revolutions per second, the second circle of holes will produce 512 pulsations of light per second—corresponding to the vibrations in the musical note

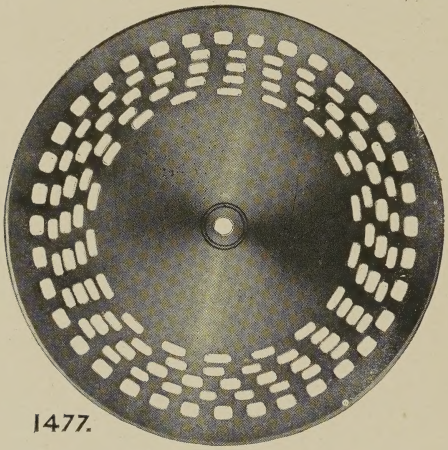

Fig. 4.
Rotating Disc.

C^1. The numbers of holes given above are in proportion to the vibrations in the notes G, C^1, D^1, E^1, G^1, (soh, doh, ray, me, soh). A change in the speed of rotation of the disc of course alters the pitch of the notes, that is, the key in which the motifs are sounded, but the intervals remain unaltered.

The optical system used to produce the image of the holes has a variable minification, so that the length occupied by the scala of five spots may be adjusted to equal the height of the letters to be read, the range of adjustment covering the various sizes of type employed in ordinary printing. The optical system is so designed that the sharpness with which the five spots are focussed upon the surface of the paper is little altered by a change in the minification, but more accurate focussing can be effected by movement of a small lens situated immediately below the selenium bridge. The spot of light corresponding to low G is caused to fall on the lowest points of such letters as j, p, y etc., the high G^1 falling on the tops of capitals and of the high letters. The three intermediate spots cover the height of the short letters. This will be readily seen by reference to Fig. 5, which is an enlarged diagram showing the path of the scala passing over the printed word " Type."

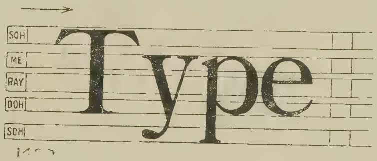

Fig. 5.

Scala passing over printed letters.

"White Sounding" Optophone. With an Optophone constructed in accordance with the above description, if all the spots of light fall on white paper—the space between two words, for example—all the notes will be sounded together in the telephone, producing a discord. If the scala passes over the letter V, the top note G^1 (high soh) will first be silenced, then E^1, D^1, C^1, D^1, E^1, G^1. Each letter will alter the succession of sounds in a different manner. This arrangement constitutes what is called the " white sounding " Optophone.

"Black Sounding" Optophone. The present improved type of Optophone is modified so as to make it "black sounding." In this form white paper is represented by silence, and notes are sounded as the scala passes over the black letters. With this Optophone the letter V is represented by the motif G^1, E^1, D^1, C^1, D^1, E^1, G^1, (s m r d r m s).

Balancer Bridge. The "black sounding" is obtained by providing a second selenium bridge which is called the "balancer"—illuminated by a small part of the intermitted light reflected aside before it reaches the paper—and connecting this bridge to the telephone and the battery in the manner shown in Fig. 6, so that the current traversing the balancer bridge (Se. No. 2) acts in the reverse direction in the telephone to that of the current through the main selenium bridge (Se. No. 1). One battery is used and the two selenium bridges are connected one to each end of the battery and both through the telephone to a selected intermediate junction of the battery in the manner shown. The balancer thus tends to cause the telephone to sound all the notes continuously, and the

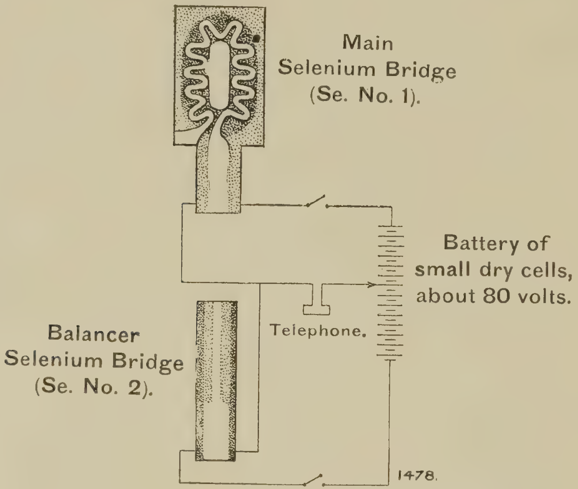

Fig. 6.
Diagram of Selenium Bridge Connections.

main selenium bridge, that receives the light reflected from the paper, annuls the effect on the telephone in respect to any note when the spot of light corresponding to that note falls on white paper. The division of the total voltage of the battery can be varied so that when the whole scala falls on white paper the telephone is silent, and notes are sounded only as the scala moves over the black letters, as previously described.

MECHANICAL CONSTRUCTION.

Base. The base of the instrument consists of an aluminium casting. It carries the book rest and the various parts of the mechanism.

Book Rest. The book rest consists of a metal frame standing on four feet and supporting a curved glass plate on which the page to be read is placed face downwards. Means are provided for clamping down the page so that it lies in close contact with the upper surface of the glass.

Rocking Shaft. Passing under the book rest, from front to back of the base, there is mounted a rocking shaft the axis of which is coincident with the axis of curvature of the book rest plate. The shaft is tubular and a slotted rod passes through it for effecting the line changing motion as described below.

Tracer. The shaft carries an aluminium casting called the "tracer," on which are mounted the electric lamp, the revolving disc and its motor, the optical system and the selenium bridges. The tracer can swing from one side of the book rest to the other.

The lamp holder is carried at the lower end of the tracer. Above it there is the rotating disc, through the perforations in which the light passes to the objective and through a small lens near the top of the tracer, above which again there is placed the main selenium bridge (Se. No. 1). Under the objective there is a concavo-convex lens, placed at an angle, which reflects a portion of the intermittent light on to the secondary selenium bridge (Se. No. 2), called the "balancer," situated in the tracer a little above the disc and to the right of its axis. (See Fig. 3.)

Governor. When the tracer is swung over to the right hand side (by means of a handle seen projecting out in front of the book rest in Fig. 1) a spring situated on the base behind the book rest is bent down and tends to throw the tracer over to the left. A governor is provided which controls the swinging of the tracer to the left. On the top of the governor box (which is situated behind the left back corner of the book holder) there is a screw with a milled head for controlling the speed of swinging of the tracer—*i.e.* the speed of passing along the line of printing. The farther this controlling screw is screwed down the slower the tracer swings and vice versa. When the controlling screw is sufficiently screwed down the swing of the tracer is stopped but starts again when the screw is slackened back.

Line Spacing. An adjustable friction gear is provided for moving the tracer down the page a line space at a time, or up the page one line space at a time if desired for re-reading a line. In the process of reading, when the tracer has passed to the end of one line, the line changer is operated and the tracer swung over, when it automatically traverses the next line.

The line changing gear is operated by a lever seen at the front of the instrument in Fig. 1. The lever is provided with a stop-screw which is adjustable and can be set to make the movement of the tracer exactly equal to the line spacing of the printing, when the lever is moved once backwards and forwards.

Switches are provided on the base of the instrument for the lamp, the motor, and the two selenium bridges.

All the controlling parts and the necessary battery connections, etc. are designed with a view to ease of manipulation by blind persons, and after a few lessons little difficulty should be experienced in adjusting and using the instrument.

Reading. In the case of the letter V already referred to, the connection of the characteristic tune or motif with the actual form of the letter is readily recognised from the succession of notes. It must not be supposed, however, that Optophone reading consists in analysing the sound motifs so as to identify the forms of the letters indicated. When the alphabet has been learned, the motif for each letter is recognised as a whole, and later in the reader's practice, the more extended motifs for syllables and even words will become familiar to his ear. A practised Optophone reader will recognise words as readily as a telegraph operator interprets a succession of clicks on the Morse code. The great rapidity that has been attained by hundreds of readers of Morse sounds encourages the hope that equal or greater speed in Optophone reading will be attained with practice. Already it has been found that with the latest type of Optophone a blind reader, after some practice, has attained a speed of reading of 60 words per minute.